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PART II

ENVIRONMENTAL PROTECTION AGENCY

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CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES AND NEW MOTOR VEHICLE ENGINES

Selective Enforcement Auditing Procedures

[6560-01]

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

[FRL 830-5]

PART 86—CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES AND NEW MOTOR VEHICLE ENGINES

Selective Enforcement Auditing Procedures

AGENCY: Environmental Protection Agency.

ACTION: Final rulemaking.

SUMMARY: The Environmental Protection Agency is making several minor clarifications and technical changes in the Selective Enforcement Auditing (SEA) regulations, published July 28, 1976 (41 FR 31472).

EFFECTIVE DATE: February 2, 1978.

ADDRESS: Director, Mobile Source Enforcement Division (EN-340), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460.

FOR FURTHER INFORMATION CONTACT:

Frank D. Slaveter, Chief, SEA Section, Mobile Source Enforcement Division (EN-340), Environmental Protection Agency, 401 M Street, Washington, D.C. 20460, 202-755-1572.

SUPPLEMENTARY INFORMATION: The Agency finds that good cause exists for omitting as unnecessary a notice of proposed rulemaking, public rulemaking procedure, and postponement of the effective date in the issuance of these amendments, in that: (1) the amendments primarily clarify the regulations, (2) they make nonsubstantive changes, and (3) they impose no additional burden on the regulated industry complying with the regulations. These amendments are described in the table below.

EXPLANATION OF AMENDMENTS

Section	Changes	Reason
1. § 86.603(c)	Vehicles are to be weighed only if required in test order.	Clarify weighing requirement.
2. § 86.605(a)(2)(v)	Requires reporting of actual curb weight of test vehicles only if test order requires weighing.	Do.
3. § 86.607(i)	Allow manufacturer to immediately ship vehicles which have passed test.	Eliminate unnecessary holding of vehicles.
4. § 86.608(c)(1)(i)	Eliminate requirement that same mileage be accumulated on all test vehicles.	Unnecessary procedural requirement.
5. § 86.609 (a), (b), (c), (d)(3), (d)(4)(iii).	Delete use of LMET's and change calculations to derive final deteriorated test results for comparison to emission standards.	Accommodate industry concern regarding differences between method used for SEA and certification for determining compliance with standards.
6. § 86.610 (a), (b)	Same as for No. 5	Same as for No. 5.
§ 86.610(c)	Discontinue test sample selection when batch sequence rejected.	Sample no longer required.
7. § 86.612 (f)(1)(ii), (g)(2)	Same as for No. 5	Same as for No. 5.
8. § 86.613(b)(3)	Eliminate interested parties from definition of "party."	Inadvertently included.

NOTE.—The Environmental Protection Agency has determined that this document does not contain a major regulation requiring preparation of an Economic Impact Statement under Executive Orders 11821 and 11949 and OMB Circular A-107.

Dated: January 23, 1978.

DOUGLAS M. COSTLE,
Administrator.

Part 86 of Chapter I, Title 40 of the Code of Federal Regulations is amended as follows:

1. In § 86.603, the first sentence of paragraph (c) (41 FR 31483) is amended to read as follows:

§ 86.603 Test orders.

* * * * * *

(c) The test order will specify the vehicle configuration selected for testing, the manufacturer's plant or storage facility from which the vehicles must be selected, the time and location at which vehicles must be selected, the batch size, the manner in which vehicles must be selected from the batch, and whether test vehicles are to be weighed. * * *

* * * * * *

2. In § 86.605, paragraph (a)(2)(v) (41 FR 31484) is revised to read as follows:

§ 86.605 Maintenance of records; submittal of information.

* * * * * *

(a) * * *
(2) * * *

(v) The drive wheel tire pressure for each test vehicle, the inertia weight class and the actual curb weight for each test vehicle required to be weighed pursuant to a test order.

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3. In § 86.607, paragraph (i) (FR 31485) is revised to read as follows:

§ 86.607 Sample selection.

* * * * * *

(i) The manufacturer shall keep on hand all untested vehicles in the batch sample until the batch is accepted or rejected in accordance with § 86.610. The manufacturer may ship any tested vehicle which has not failed in accordance with § 86.610(a). However, once a manufacturer ships any vehicle from any batch sample, he relinquishes the prerogative to conduct retests as provided in § 86.608(i).

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4. In § 86.608, paragraphs (c)(1) (41 FR 31485) and (i) (41 FR 31486) are revised to read as follows:

§ 86.608 Test procedures.

* * * * * *

(c) * * *

(1) Mileage accumulation may be performed in any manner the manufacturer desires.

* * * * * *

(i) The manufacturer will be permitted to retest any test vehicle: *Provided,* That all vehicles selected for testing are tested the same number of times and that not more than three tests per vehicle are performed. The manufacturer may accumulate additional mileage before conducting a retest.

5. In § 86.609 the title and paragraphs (a), (b), (c), (d)(3), and (d)(4)(iii) (41 FR 31486) are amended to read as follows:

§ 86.609 Calculation and reporting of test results.

(a) Initial tests results shall be calculated following the method prescribed in Appendix IX or X, as appropriate, of this part and rounded in accordance with ASTM E29-67 to the number of places to the right of the decimal point indicated by expressing the appropriate emission standard to three significant figures.

(b) Final test results for each test vehicle shall be calculated by summing the initial test results derived in § 86.609(a) above for each test vehicle, dividing by the number of tests conducted on the vehicle, and rounding, in accordance with ASTM E29-67, to the same number of decimal places to

the right of the decimal point as the initial test results.

(c) The final deteriorated test results for each test vehicle shall be calculated by multiplying the final test results by the appropriate deterioration factor derived from the certification process for the engine family and model year to which the selected configuration belongs and rounded in accordance with ASTM E29-67 to two significant figures. For the purpose of this paragraph, if a deterioration factor as computed during the certification process is less than one, that deterioration factor shall be one.

(d) * * *

(3) Deterioration factors for the selected configuration.

(4) * * *

(iii) Test number, date, initial test results, final results and final deteriorated test results for all valid and invalid exhaust emission tests, and the reason for invalidation.

* * * * *

6. In § 86.610, paragraphs (a), (b) and (c) (41 FR 31486) are revised to read as follows:

§ 86.610 Acceptance and rejection of batches.

(a) A failed vehicle is one whose final deteriorated test result for one or more of the three exhaust pollutants when compared to the applicable emission standard for that pollutant, exceeds that standard.

(b) The batch from which a batch sample is selected will be accepted or rejected for each pollutant based upon the number of test vehicles in the batch sample with final deteriorated test results exceeding the applicable emission standards. A sufficient number of test samples of size determined by entering Appendix VIII, Table II at the appropriate code letter will be drawn from the batch sample and the vehicles tested until the cumulative number of vehicles whose final deteriorated test results exceed the emission standard for each pollutant is less than or equal to the acceptance number or greater than or equal to the rejection number appropriate for the cumulative number of vehicles tested. The acceptance and rejection numbers at the appropriate code letter in Appendix VIII, Table II will be used in determining whether the acceptance or rejection of a batch has occurred. Once a batch is accepted or rejected for a particular pollutant, the number of vehicles whose final deteriorated test results exceed the emission standard for that pollutant shall not be considered any further for the purposes of the audit of that batch.

(c) Test samples from the batch sample shall continue to be drawn and tested until a decision of acceptance or rejection can be made with regard to each pollutant for the batch or until the batch sequence is rejected in accordance with § 86.611(a).

* * * * *

7. In § 86.612, paragraphs (f)(1)(ii) and (g)(2) (41 FR 31487) are amended to read as follows:

§ 86.612 Suspension and revocation of certificates of conformity.

* * * * *

(f) * * *

(1) * * *

(ii) demonstrate that the vehicle's final deteriorated test results conform to the applicable emission standards by retesting the vehicle in accordance with these regulations.

* * * * *

(g) * * *

(2) Demonstrate that the vehicle configuration for which the certificate of conformity has been suspended does in fact comply with these regulations by testing vehicles from consecutively produced batches of that vehicle configuration at the plant or plants specified by the Administrator in accordance with § 86.610 and § 86.611 and the conditions specified in the initial test order: Except, That if the manufacturer elects to continue testing individual vehicles after suspension of a certificate, the certificate is reinstated for any vehicle actually determined to have its final deteriorated test results in conformance with the applicable emission standards through testing in accordance with the applicable test procedures: *Provided*, That the Administrator had not revoked the certificate pursuant to paragraph (e) above.

* * * * *

8. In § 86.613 paragraph (b)(3) (41 FR 31487) is amended to read as follows:

§ 86.613 Hearings on suspension and revocation of certificate of conformity.

* * * * *

(b) * * *

(3) "Party" shall include the Agency and the manufacturer.

* * * * *

(Secs. 206, 208, 301(a), Clean Air Act, as amended (42 U.S.C. 7525, 7542, 7601(a), formerly 42 U.S.C. 1857f-5, 1875f-6, 1857g(a) which was reclassified by 91 Stat. 685 (Aug. 7, 1977)).)

[FR Doc. 78-2702 Filed 2-1-78; 8:45 am]

[6560-01]

[FRL 830-6]

PART 86—CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES AND NEW MOTOR VEHICLE ENGINES

Selective Enforcement Auditing Procedures

AGENCY: Environmental Protection Agency.

ACTION: Final rulemaking.

SUMMARY: The Environmental Protection Agency (EPA) is revising the vehicle exhaust emission test procedures for the Selective Enforcement Auditing (SEA) regulations for 1978 and later model years. This action is intended to make the test procedure used for SEA substally consistent with the test procedures used for certification of prototype vehicles, and to make certain minor clarifications.

EFFECTIVE DATE: February 2, 1978.

ADDRESS: Director, Mobile Source Enforcement Division (EN-340), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460.

FOR FURTHER INFORMATION CONTACT:

Frank D. Slaveter, Chief, SEA Section, Mobile Source Enforcement Division (EN-340), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460, 202-755-1572.

SUPPLEMENTARY INFORMATION: On January 13, 1976, EPA published a notice of proposed rulemaking (NPRM) in the FEDERAL REGISTER (41 FR 21222) setting forth proposed amendments to the Code of Federal Regulations among which were changes to the test procedures used for certification of prototype vehicles to the emission standards. After consideration of comments received on the proposed amendments, appropriate changes were made and final regulations were published in the FEDERAL REGISTER (41 FR 35626). Included in these amendments are procedures for testing vehicles only for exhaust emissions.

The preamble to the Proposed Selective Enforcement Auditing Procedures published in the FEDERAL REGISTER (39 FR 45360) December 31, 1974, stated that the prescribed test for SEA was the official Federal Test Procedure. No serious objection was raised to the use of this test procedure. However, several manufacturers recommended that test procedures should be published separately for application to SEA since all the details of their application in certification might not be appropriate for SEA. This recommendation was adopted for the final SEA regulations. These amendments establish test procedures for SEA for 1978 and later gasoline-fueled and diesel-

fueled light-duty vehicles and light-duty trucks consistent with the test procedures in the certification regulations for exhaust emissions only.

The Agency finds good cause (1) for omitting as unnecessary a notice of proposed rulemaking and public rulemaking procedure, and (2) for making these changes effective upon publication, so that the changes will apply to production now underway. Two of the changes made by this notice clarify the regulations without changing their substance or imposing any burden on the regulated industry. The other changes are required to make the SEA procedures consistent with the certification procedures, on which the public was provided opportunity to comment before they were adopted. Finally, the manufacturers have been aware of these planned changes for some time, and should not be burdened by the requirement that they comply immediately.

These amendments are described in the table below.

EXPLANATION OF AMENDMENTS

Section	Changes	Reason
1. § 86.608(a)	App. IX applies for 1977 vehicles and trucks and app. X applies for 1978 and later. Add provision for alternate test procedures.	Make SEA test procedures for 1978 and later vehicles and trucks consistent with those for certification.
2. App. IX	App. IX to apply to 1977 vehicles and trucks.	Clarify that app. IX applies to 1977 vehicles and trucks.
3. App. X	Add app. X	Test procedures for 1978 and later vehicles and trucks.

The following table summarizes the differences between the 1977 and 1978 test procedures.

1977 procedures (app. IX)	1978 procedures (app. X)	Change	Reason
II(a)(2) II(b)(3)(i) (41 FR 31493).	II(a)(2) II(b)(4)...	Add provision limiting commercial fuel to that which is available in the United States. Also add provision to allow usage of test fuel for mileage accumulation.	Clarification of regulation intent.
II(b)(2) (41 FR 31493) ..	do	Add specifications for diesel fuel	(1)
III(1)(iii) (41 FR 31493).	do	Add provision prohibiting slave evaporative canisters.	(1)
IV (41 FR 31493)	do	Delete provisions allowing use of slave fuel tanks. Add heat build procedure.	(1)
VI(e)(2) (41 FR 31494) .	do	Delete details for alternate method of determining vehicle load horsepower. Reserve (i)(A) and (i)(B).	Outdated procedure.
VI, XV (41 FR 31495, 41 FR 31501).	VI (j) XIV	Add provisions to require measuring the actual driving distance on the rolls, and the appropriate changes in calculations of mass emissions.	(1)
VII, VIII, IX (41 FR 31495).	VII	Combine and update sections on transmission operations; make consistent with owner's manual.	(1)
X (41 FR 31495)	VIII	Make starting procedure consistent with owner's manual.	(1)
XII(a)(4) (41 FR 31499).	X	For system calibration, reference certification publication.	(1)
XIII(b) (11) and (13) (41 FR 31401).	XI(b) (11) and (13).	Delete time limit for ambient bag analysis	(1)

[1] Consistency with certification regulations.

NOTE.—The Environmental Protection Agency has determined that this document does not contain a major regulation requiring preparation of an Economic Impact Statement under Executive Orders 11821 and 11949 and OMB Circular A-107.

Dated: January 23, 1978.

DOUGLAS COSTLE,
Administrator.

Part 86 of Chapter I, Title 40 of the Code of Federal Regulations is amended as follows:

1. In § 86.608 paragraph (a) amended to read as follows:

§ 86.608 Test procedures.

(a) The prescribed test procedures are contained in Appendix IX for 1977 model year light-duty vehicles and light-duty trucks and in Appendix X for 1978 model year and later light-duty vehicles and light-duty trucks. The Administrator may, on the basis of a written application by a manufacturer, prescribe test procedures other than those set forth in these appendixes for any motor vehicle which he determines is not susceptible to satisfactory testing by the procedures set forth in these appendixes.

* * * * *

2. By changing the title of Appendix IX to read as follows:

APPENDIX IX—SELECTIVE ENFORCEMENT AUDITING TEST PROCEDURES FOR 1977 MODEL YEAR LIGHT-DUTY VEHICLES AND LIGHT-DUTY TRUCKS

3. By adding Appendix X to read as follows:

APPENDIX X—SELECTIVE ENFORCEMENT AUDITING TEST PROCEDURES FOR 1978 AND LATER MODEL YEAR LIGHT-DUTY VEHICLES AND LIGHT-DUTY TRUCKS

I. TEST PROCEDURES

Vehicles shall be tested for conformity with following procedures:

(1) Gasoline-fueled vehicles:

(i) The test consists of prescribed sequences of fueling, parking, and operating conditions. The exhaust gases generated during vehicle operation are diluted with air and sample continuously for subsequent analysis of specific components by prescribed analytical techniques. The test applies to vehicles equipped with catalytic or direct-flame afterburners, induction system modifications, or other systems or to uncontrolled vehicles and engines.

(ii) The exhaust emission test is designed to determine hydrocarbon, carbon monoxide, and oxides of nitrogen mass emissions while simulating an average trip of 7.5 miles in an urban area. The test consists of engine startups and vehicle operation on a chassis dynamometer through a specified driving schedule, as described in Appendix I to 40 CFR Part 86. A proportional part of the diluted exhaust emissions is collected continuously, for subsequent analysis, using a constant volume (variable dilution) sampler.

(2) Diesel vehicles:

(i) The test consists of prescribed sequences of fueling, parking, and operating conditions. The exhaust gases generated during vehicle operation are diluted with air and sampled continuously for analysis of Diesel exhaust hydrocarbons and subsequent analysis of other specific components by prescribed techniques. The test applies to vehicles equipped with catalytic or direct flame afterburners, other control systems or to uncontrolled vehicles and engines. All test phases are conducted within an ambient temperature range of 68 to 86° F.

(ii) The exhaust emission test is designed to determine hydrocarbon, carbon monoxide, and oxides of nitrogen mass emissions while simulating an average trip of 7.5 miles in an urban area. The test consists of engine startups and vehicle operation on a chassis dynamometer through a specified driving schedule, as described in Appendix I to 40 CFR Part 86. Using a consistant volume (variable dilution) sampler, a proportional part of the diluted exhaust gas is analyzed continuously for hydrocarbons and an additional proportional part of the diluted exhaust gas is collected in bags for subsequent analysis of the other components.

II. FUEL SPECIFICATIONS

(a) Gasoline.

(1) Gasoline having the following specifications will be used by the Administrator in exhaust emission testing. Gasoline having

the following specifications or substantially equivalent specifications approved by the Administrator, shall be used by the manufacturer in testing,

Item designation	ASTM	Leaded	Unleaded
Octane, research, minimum	D2699	100	93
Pb. (organic), grams/U.S. gallon		[1]1.4	0.00–0.05
Distillation range			
IBP[2], °F	D86	75–95	75–95
10 pct point °F	D86	120–135	120–135
50 pct point °F	D86	200–230	200–230
90 pct point °F	D86	300—325	300–325
EP[3], °F	D86	415	415
Sulfur[4], weight percent	D1266	0.10	.10
Phosphorus[5], grams/U.S. gallon		.01	.005
RVP[3] [4] pounds	D323	8.7–9.2	8.7–9.2
Hydrocarbon composition			
Olefins[6], percent	D1319	10	10
Aromatics[6], percent	D1319	35	35
Saturates	D1319	(a)	(a)

[1] Minimum.
[2] For testing at altitudes above 1,219 m (4,000 ft) the specified range is 75–105.
[3] For testing unrelated to evaporative emissions, the range is 8.0–9.2 lbs.
[4] For testing at altitudes above 1,219 m (4,000 ft) the specified range is 7.9–9.2.
[5] Maximum.
[6] Remainder.

(2) Gasoline representative of commercial gasoline which will be generally available in the United States through retail outlets shall be used in mileage accumulation. Emission test fuel meeting the specifications in (a)(1) of this section may be used for mileage accumulation.

(3) The specifications range of the gasoline used under paragraphs (a)(1) and (a)(2) of this section shall be recorded.

(b) Diesel fuel. (1) The diesel fuels employed for testing shall be clean and bright, with pour and cloud points adequate for operability. The diesel fuel may contain nonmetallic additives as follows: Cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, and dispersant.

(2) Diesel fuel meeting the following specifications, or substantially equivalent specifications approved by the Administrator, shall be used in exhaust emissions testing: The grade of diesel fuel recommended by the engine manufacturer commercially designated as "Type 2-D", shall be used.

Item	ASTM	Type 2-D
Cetane	D613	42–50
Distillation range	D86	
IBP, °F		340–400
10 pct point, °F		400–460
50 pct point, °F		470–540
90 pct point, °F		550–610
EP, °F		580–660
Gravity, °API	D287	33–37
Total sulfur, percent	D129 or D2622.	0.2–0.5
Hydrocarbon composition.	D1319	
Aromatics, pct		[1]27
Paraffins, naphthenes, olefins.		([2])
Flashpoint, °F	D93	130
Viscosity, centistokes	D445	2.0–3.2

[1] Minimum.
[2] Remainder.

(3) Diesel fuel meeting the following specifications, or substantially equivalent specifications approved by the Administrator, or testing fuel designated in paragraphs (b)(1) and (b)(2) of this section shall be used in mileage accumulation. The grade of diesel fuel recommended by the engine manufacturer, commercially designated as "Type 2-D," shall be used.

Item	ASTM	Type 2-D
Cetane	D613	38–58
Distillation range:		
90 pct point, °F	D86	430–630
Gravity, °API	D287	30–42
Total sulfur, pct. (minimum).	D129 or D2622.	0.2
Flashpoint, °F (minimum).	D93	130
Viscosity, centistokes	D455	1.5–4.5

(4) Other petroleum distillate fuels may be used for testing and mileage accumulation provided they are commercially available in the U.S., and

(i) Information, acceptable to the Administrator, is provided to show that only the designated fuel would be in customer service, and

(ii) Use of a fuel listed under paragraphs (b)(1), (b)(2), and (b)(3) of this section would have a detrimental effect on emissions or durability, and

(iii) Written approval from the Administrator of the fuel specifications was provided prior to the start of testing.

(5) The specification range of the fuels used under paragraphs (b)(1), (b)(2), (b)(3), and (b)(4) of this section shall be recorded.

III. GASOLINE-FUELED VEHICLE PREPARATION

Gasoline-fueled vehicles to be tested in accordance with this appendix shall be prepared as follows:

(1)(i) Inspect the fuel system carefully to insure the absence of any leaks to the atmosphere of either liquid or vapor which might affect the accuracy of the test or the performance of the control system. Such inspection shall include the application of a pressure of 14.5 inches of water (plus or minus 0.5 inches of water) to the fuel system. The pressure should be applied and allowed to stabilize and the fuel system isolated from the pressure source. The fuel system may not lose more than 2 inches of water pressure in five minutes beginning with the isolation of the fuel system. Corrective action, if required, shall be performed in accordance with § 86.608(d) and be reported with the final test report under § 86.609(d).

(ii) Care should be exercised, in the application of any pressure tests, neither to purge nor load the evaporative emission control system.

(iii) The vehicle evaporative emission system may not be modified by component addition, deletion, or substitution during any Selective Enforcement Audit, except to comply with section IV(a)(2)(i)(A) of this appendix if approved by the Administrator in advance.

IV. VEHICLE PRECONDITIONING

(a) Gasoline fueled vehicles to be tested in accordance with this appendix shall be preconditioned as follows:

(1) Preconditioning.

(i) The fuel tank(s) shall be drained and filled with the specified test fuel (II.(a)(1)) to 40 percent of nominal capacity, rounded to the nearest whole U.S. gallon,

(ii) The fuel added to the vehicle tank(s) shall have an initial temperature of no more than 86° F. The evaporative emission control system or device shall not be abnormally purged or loaded as a result of draining or filling the tank(s),

(iii) The test vehicle shall be placed on the dynamometer and operated over a simulated trip, according to the requirements of section V through XI of this appendix. The engine need not be cold when starting the run on the dynamometer and a single trip of 7.5 miles shall be made. Longer preconditioning may be permitted with advance approval of the Administrator. The test vehicle shall not be used to set dynamometer horsepower. During this operation the ambient temperature shall be between 68° F and 86° F.

(iv) Within 5 minutes of completion of preconditioning the vehicle shall be driven or removed from the dynamometer and parked. The vehicle shall be stored for not less than 11 hours and not more than 36 hours at a temperature between 68° F and 86° F prior to the start of the heat build.

(2) Heat build. (i) Vehicle preparation.

(A) Prepare the fuel tank(s) for recording the temperature of the prescribed test fuel at the approximate mid-volume of the fuel. Fuel temperature may be measured at other than mid-volume if approved in advance by the Administrator.

(B) The fuel tank of the test vehicle shall be drained and refilled with the specified test fuel to 40 percent of nominal capacity, rounded to the nearest whole U.S. gallon. The temperature of the fuel prior to delivery to the fuel tank shall be between 50° F and 60° F. Care should be exercised against abnormal loading of the evaporative emission control system as a result of fueling the tank.

(ii) Temperature recording system. Strip chart recorder(s) or automatic data processor shall be used to record ambient and vehicle fuel tank temperature during the heat build. The temperature recorder or data processor shall record the temperature at least once every minute. The recording system shall be capable of resolving time to ±15 seconds and capable of resolving temperature to ±0.75° F (0.42° C). The temperature recording system (recorder and sensor) shall have an accuracy of ±3° F (1.7° C). The recorder (data processor) shall have a time accuracy of ±15 seconds and a precision of ±15 seconds.

(iii) Test sequence.

(A) When the fuel temperature reaches 60±2° F, the fuel tank cap(s) shall be installed, and the fuel tank shall be heated in such a way that its temperature change conforms to the following function to within ±3° F (±1.6° C):

$F = T. + 0.4t$

for SI units, $C = T. + (2/9)t$

Where:

F = fuel temperature, °F
C = fuel temperature, °C
t = time since beginning of test, minutes.
T = initial temperature.

After 60±2 minutes of heating, the fuel temperature rise shall be 24±1° F (±0.5° C).

(B) The heat build ends after 60±2 minutes of heating.

(C) A wait of up to 60 minutes is permitted between the end of the heat build and the beginning of the cold start exhaust test.

(D) Ambient temperature during the heat build shall be between 68 and 86° F.

(b) Diesel vehicles to be tested in accordance with this appendix shall be preconditioned as follows:

(1) The fuel tank(s) of each test vehicle shall be drained and refilled with specified test fuel (II.(b) (1)), (2), (4) to 40 percent of nominal capacity, rounded to the nearest whole U.S. gallon.

(2) The test vehicle shall be placed on the dynamometer and operated over a simulated trip, according to the requirements of sections V through XI of this appendix. The engine need not be cold when starting the run on the dynamometer and a single trip of 7.5 miles shall be made. The test vehicle shall not be used to set dynamometer horsepower.

(3) Within 5 minutes of completion of preconditioning the vehicle shall be driven or removed from the dynamometer and parked. The vehicle shall be stored for not less than 12 hours at a temperature between 68° F and 86° F prior to the start of the dynamometer test.

V. DYNAMOMETER DRIVING SCHEDULE

(a) The dynamometer driving schedule to be followed consists of a nonrepetitive series of idle, acceleration, cruise, and deceleration modes of various time sequences and rates. The driving schedule is defined by a smooth transition through the speed vs. time relationship listed in Appendix I of 40 CFR Part 86. The time sequence begins upon starting the vehicle according to the startup procedure described in section VIII of this appendix.

(b) The speed tolerance at any given time on the dynamometer driving schedule prescribed in Appendix I or as plotted on a driver's aid chart approved by the Administrator, when conducted to meet the requirements of Section VI of this appendix, is defined by upper and lower limits. The upper limit is 2 m.p.h. higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 m.p.h. lower than the lowest point on the trace within 1 second of the given time. Speed variations greater than the tolerances (such as occur when shifting manual transmission vehicles) are acceptable provided they occur for less than 2 seconds on any one occasion. Speeds lower than those prescribed are acceptable provided the vehicle is operated at maximum available power during such occurrences. Further, speed deviations from those prescribed due to stalling are acceptable provided the provisions of section VIII(e) are adhered to. When conducted to meet the requirements of section IV, the speed tolerance shall be as specified above, except that the upper and lower limits shall be 4 m.p.h.

VI. DYNAMOMETER PROCEDURE

(a) The dynamometer run consists of two tests, a "cold" start test after a minimum 12-hour soak (according to the provisions of section IV of this appendix) and a "hot" start test with a 10-minute soak between the two tests. Engine startup (with all accessories turned off), operation over the driving schedule, and engine shutdown make a complete cold start test. Engine startup and operation over the first 505 seconds of the driving schedule complete the hot start test. The exhaust emissions are diluted with air to a constant volume and a portion is sampled continuously during each phase. (Diesel hydrocarbons are analyzed continuously.) The composite (flow integrated) samples collected in bags are analyzed for hydrocarbons (except Diesel), carbon monoxide, carbon dioxide, and oxides of nitrogen. A parallel sample of the dilution air is similarly analyzed for hydrocarbon, carbon monoxide, carbon dioxide, and oxides of nitrogen.

(b) During dynamometer operation, a fixed speed cooling fan shall be positioned so as to direct cooling air to the vehicle in an appropriate manner with the engine compartment cover open. The fan capacity shall normally not exceed 5,300 c.f.m. If, however, the manufacturer can show that during field operation the vehicle receives additional cooling, the fan capacity may be increased or additional fans used if approved in advance by the Administrator. In the case of vehicles with front engine compartments, the fan(s) shall be squarely positioned between 8 and 12 inches in front of the cooling air inlets (grill). In the case of vehicles with rear engine compartments (or if special designs make the above impractical), the cooling fan(s) shall be placed in a position to provide sufficient air to maintain engine cooling.

(c) The vehicle shall be nearly level when tested in order to prevent abnormal fuel distribution.

(d) Flywheels, electrical, or other means of simulating inertia as shown in the following table shall be used. If the equivalent inertia specified is not available on the dynamometer being used, the next higher equivalent inertia (not to exceed 250 lbs.) available shall be used.

Loaded vehicle weight, pounds	Equivalent inertia weight, pounds	Road load power at 50 mi/h, horsepower
Up to 1,125	1,000	5.9
1,126 to 1,375	1,250	6.5
1,376 to 1,625	1,500	7.1
1,626 to 1,875	1,750	7.7
1,876 to 2,125	2,000	8.3
2,126 to 2,375	2,250	8.8
2,376 to 2,625	2,500	9.4
2,626 to 2,875	2,750	9.9
2,876 to 3,250	3,000	10.3
3,251 to 3,750	3,500	11.2
3,751 to 4,250	4,000	12.0
4,251 to 4,750	4,500	12.7
4,751 to 5,250	5,000	13.4
5,251 to 5,750	5,500	13.9
5,751 and above	5,500	14.4

(e) Power absorption unit adjustment.

(1) The power absorption unit shall be adjusted to reproduce road load power at 50 m.p.h. true speed. The indicated road load power setting shall take into account the dynamometer friction. The relationship between road load (absorbed) power and indicated road load power for a particular dynamometer shall be determined by the procedure outlined in Appendix II of 40 CFR Part 86 or other suitable means.

(2) The road load power listed in the table above shall be used or the vehicle manufacturer may determine the road load power by an alternate procedure requested by the manufacturer and approved in advance by the Administrator (such as the coastdown method).

(i) Gasoline-fueled vehicles:

(A) [Reserved]

(B) [Reserved]

(ii) Diesel vehicles:

(A) Measuring the fuel flow rate of a representative vehicle of the same equivalent weight class, when operated on a level road under balanced wind conditions at a true speed of 50 m.p.h., and

(B) Noting the dynamometer indicated road load horsepower setting required to reproduce that fuel flow rate when the same vehicle is operated on the dynamometer at a true speed of 50 m.p.h. The tests on the road and on the dynamometer shall be performed with the same vehicle ambient absolute pressure (usually barometric), i.e., within ±5 mm. Hg.

(3) The road load power shall be adjusted according to the following if applicable: Where it is expected that more than 33 percent of the vehicles in an engine family will be equipped with air conditioning, the road load power listed above or as determined in paragraph (e)(2) of this section shall be increased by 10 percent when testing all vehicles within such engine family if those vehicles are intended to be offered with air conditioning in production.

(f) The vehicle speed (m.p.h.) as measured from the dynamometer rolls shall be used for all conditions. A speed v. time recording, as evidence of dynamometer test validity, shall be supplied on request of the Administrator.

NOTE.—When using a two-roll dynamometer a truer speed-time trace may be obtained by minimizing the rocking of the vehicle in the rolls. The rocking of the vehicle changes the tire rolling radius on each roll. The rocking may be minimized by restraining the vehicle horizontally (or nearly so) by using a cable and winch.

(g) The drive wheel tires may be inflated up to 45 psig in order to prevent tire damage. Slave tires may be substituted for the drive wheel tires in which the vehicle is equipped provided they are the same size. The drive wheel tire pressure shall be recorded.

(h) If the dynamometer has not been operated during the 2-hour period immediately preceding the test it shall be warmed up for 15 minutes by operating it at 30 m.p.h. using a nontest vehicle.

(i) If the dynamometer horsepower must be adjusted manually, it shall be set within 1 hour prior to the exhaust emissions test. The test vehicle shall not be used to make this adjustment. Dynamometers using automatic control of preselectable power settings may be set anytime prior to the beginning of the test.

(j) The driving distance as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the transient cold start, stabilized cold start, and transient hot start phases of the test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

(k) Practice runs over the prescribed driving schedule may be performed at test points, provided an emission sample is not taken, for the purpose of finding the minimum throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustments.

VII. TRANSMISSIONS

(a) All test conditions, except as noted, shall be run according to the manufacturer's recommendation to the ultimate purchaser as detailed in the owner's manual.

(b) Vehicles equipped with free wheeling or overdrive shall be tested with these features operated according to the manufacturer's recommendations in the owner's manual.

(c) Idle modes shall be run with automatic transmission in "Drive" and the wheels

braked; manual transmissions shall be in gear with the clutch disengaged, except first idle (see section VIII).

(d) The vehicle shall be driven with minimum accelerator pedal movement to maintain the desired speed.

(e) Accelerations shall be driven smoothly according to the manufacturer's recommendation in the owner's manual. If the manufacturer does not recommend shift speeds in owner's manual, manual transmission vehicles shall be shifted as follows: A three-speed vehicle shall be shifted from first to second gear at 15 m.p.h. and from second to third gear at 25 m.p.h.; and four-speed vehicle shall be shifted from first to second gear at 15 m.p.h., from second to third gear at 25 m.p.h. and from third to fourth gear at 40 m.p.h.; a five-speed vehicle shall be shifted the same as a four-speed vehicle with the fifth gear used at the manufacturer's option. For manual transmissions, the operator shall release the accelerator pedal during each shift and accomplish the shift with minimum time. If the vehicle cannot accelerate at the specified rate, the vehicle shall be operated with the accelerator pedal fully depressed until the vehicle speed reaches the value prescribed for that time in the driving schedule.

(f) The deceleration modes shall be run in gear using brakes or accelerator pedal as necessary to maintain the desired speed. Manual transmission vehicles shall have the clutch engaged and shall not change gears from the previous mode. For those modes which decelerate to zero, manual transmission clutches shall be depressed when the speed drops below 15 m.p.h. (24.14 km/h), when engine roughness is evident, or when engine stalling is imminent.

(g) Downshifting is allowed at the beginning of or during a power mode in accordance with the manufacturer's recommendation in the owner's manual.

VIII. ENGINE STARTING AND RESTARTING

(a) Gasoline-fueled vehicles:

(1) The engine shall be started according to the manufacturer's recommended starting procedures as detailed in the owner's manual. The initial 20-second idle period shall begin when the engine starts.

(2) Choke operation:

(i) Vehicles equipped with automatic chokes shall be operated according to the instructions in the owner's manual including choke setting and "kick-down" from cold fast idle. The transmission shall be placed in gear 15 seconds after the engine is started. If necessary, braking may be employed to keep the drive wheels from turning.

(ii) Vehicles equippped with manual chokes shall be operated according to the owner's manual. The transmission shall be placed in gear 15 seconds after the engine is started.

(3) The operator may use the choke, accelerator pedal, etc., where necessary to keep the engine running.

(4) If the owner's manual does not specify a warm engine starting procedure, the engine (automatic and manual choke engines) shall be started by depressing the accelerator pedal about half way and cranking the engine until it starts.

(b) Diesel vehicles. The engine shall be started according to the manufacturer's recommended starting procedures as detailed in the owner's manual. The initial 20-second idle period shall begin when the engine starts. The transmission shall be placed in gear 15 seconds after the engine is started. If necessary, braking may be employed to keep the drive wheels from turning.

(c) If the vehicle does not start after 10 seconds of cranking, cranking shall cease and the reason for failure to start shall be determined. The revolution counter on the constant volume sampler (and the hydrocarbon integrator when testing Diesel vehicles, see section XI) shall be turned off and the sample solenoid valves placed in the "dump" position during this diagnostic period. In addition, either the positive displacement pump should be turned off or the exhaust tube disconnected from the tailpipe during the diagnostic period. If failure to start is an operational error, the vehicle shall be rescheduled for testing.

(1) If failure to start occurs during the cold portion of the test and is caused by vehicle malfunction, corrective action of less than 30 minutes duration may be taken and the test continued. The sampling system shall be reactivated at the same time cranking begins. When the engine starts, the driving schedule timing sequence shall begin. If failure to start is caused by vehicle malfunction and the vehicle cannot be started, the test shall be voided, corrective action taken, and the vehicle rescheduled for testing. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

(2) If a failure to start occurs during the hot start portion of the test and is caused by vehicle malfunction, the vehicle must be started within 1 minute of key on. The sampling system shall be reactivated at the same time cranking begins. When the engine starts, the driving schedule timing sequence shall begin. If the vehicle cannot be started within 1 minute of key on, the test shall be voided, and corrective action taken, and the vehicle rescheduled for testing. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

(d) If the engine "false starts," the operator shall repeat the recommended starting procedure (such as resetting the choke, etc.).

(e) Stalling. (1) If the engine stalls during an idle period, the engine shall be restarted immediately and the test continued. If the engine cannot be started soon enough to allow the vehicle to follow the next acceleration as prescribed, the driving schedule indicator shall be stopped. When the vehicle restarts the driving schedule indicator shall be reactivated.

(2) If the engine stalls during some operating mode other than idle, the driving schedule indicator shall be stopped, the vehicle restarted, accelerated to the speed required at that point in the driving schedule and the test continued.

(3) If the vehicle will not restart within 1 minute, the test shall be voided, corrective action taken, and the vehicle rescheduled for test. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

IX. SAMPLING AND ANALYTICAL SYSTEM (EXHAUST EMISSIONS)

(a) Gasoline-fueled vehicles. (1) Schematic drawings. The following figures (Figs. 1 and 2) are schematic drawings of the exhaust gas sampling and analytical systems which will be used for testing under the regulations in this part. Since various configurations of the required components can produce accurate results, these schematic drawings are not to be interpreted literally and exact conformance is not mandatory. Additional components such as instruments, valves, solenoids, pumps, and switches may be used to provide additional information and coordinate the functions of the component systems.

(2) Component description (exhaust gas sampling system). The following components will be used in the exhaust gas sampling systems for testing under the regulations in this subpart. See Figure 1. Other types of constant volume samplers may be used if shown to yield equivalent results and if approved in advance by the Administrator.

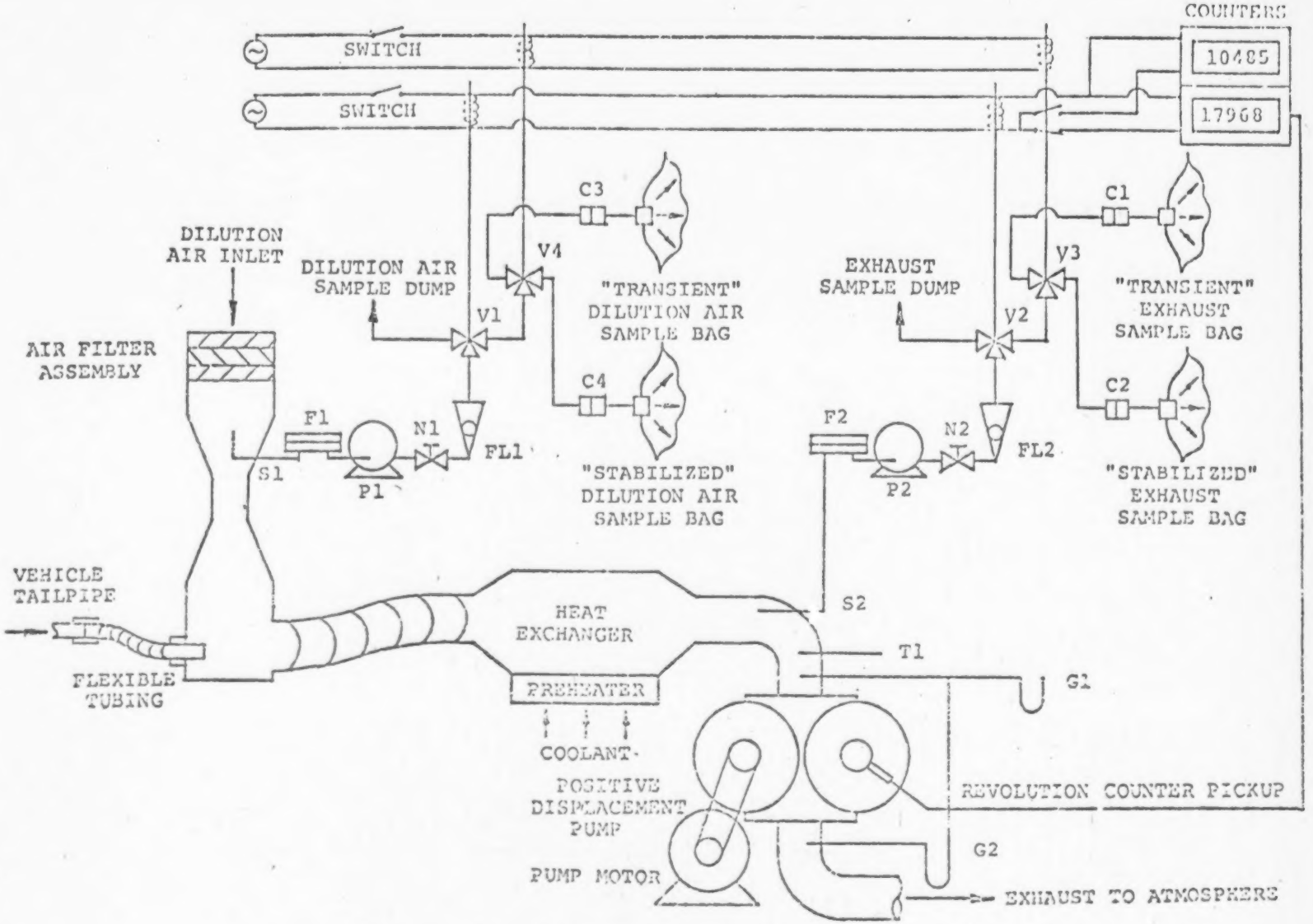

Figure 1 - Exhaust Gas Sampling System

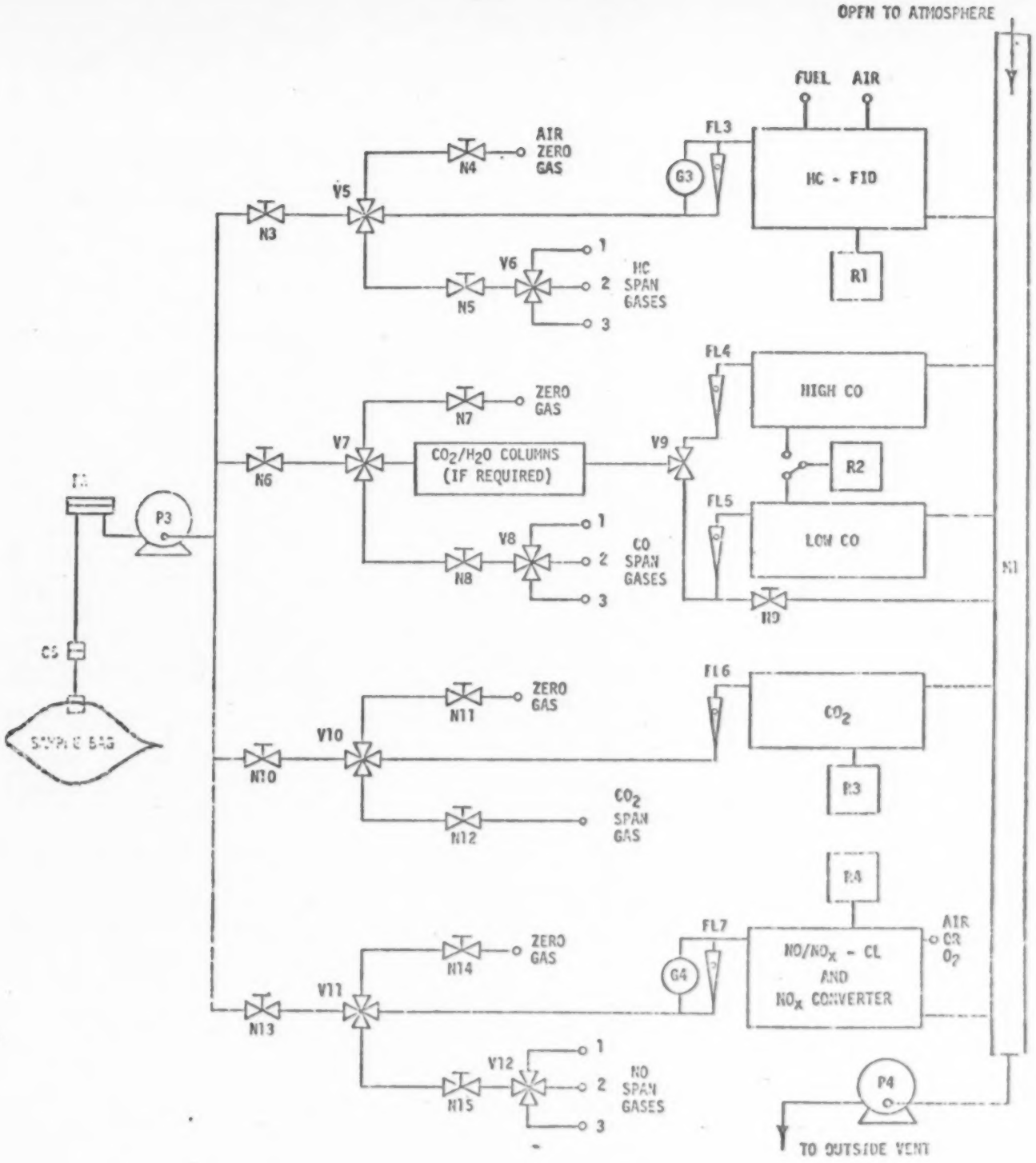

Figure ·2 Exhaust Gas Analytical System

(i) A dilution air filter assembly consisting of a particulate filter to remove solid matter from the dilution air and thus increase the life of the charcoal filter; a charcoal filter to reduce and stabilize the background hydrocarbon level; and a second particulate filter to remove charcoal particles from the airstream.

(ii) A leak-tight connector and tube to the vehicle tailpipe. The tubing shall be sized and connected in such a manner that the static pressure variations in the vehicle tailpipe(s) remain within ±5 inches of water of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe(s). Sampling systems capable of tolerance of ±1 inch of water will be used by the Administrator if a written request by the manufacturer substantiates the need for this closer tolerance.

(iii) A heating system to preheat exchanger to within ±10° F of its operating temperature before the test begins.

(iv) A heat exchanger capable of limiting the gas mixture temperature variation during the entire test to ±10° F from the total test average as measured at a point immediately ahead of the positive displacement pump.

(v) A positive displacement pump in order to pump the dilute exhaust mixture. The pump capacity (300 to 350 c.f.m. if sufficient for testing most vehicles) shall be large enough to virtually eliminate water condensation in the system. (See Appendix III of 40 CFR Part 86 for one-flow calibration technique.) Other suitable calibration techniques may be used if approved in advance by the Administrator.

(vi) Temperature sensor (T1) with an accuracy of ±2° F to allow continuous recording of the temperature of the dilute exhaust mixture entering the positive displacement pump.

(vii) Gauge (G1) with an accuracy of ±3 mm. Hg to measure the pressure depression of the dilute exhaust mixture entering the positive displacement pump, relative to atmospheric pressure.

(viii) Gauge (G2) with an accuracy of ±3 mm. Hg to measure the pressure increase across the positive displacement pump.

(ix) Sample probes (S1 and S2) pointed upstream to collect samples from the dilution airstream and the dilute exhaust mixture.

(x) Filters (F1 and F2) to remove particulate matter from dilution air and dilute exhaust samples.

(xi) Pumps (P1 and P2) to pump the dilution air and dilute exhaust into their respective sample collection bags.

(xii) Flow control valves (N1 and N2) to regulate flows to sample collection bags, at constant flow rates. The minimum sample flow rate shall be 10 c.f.h.

(xiii) Flowmeters (FL1 and FL2) to insure, by visual observation, that constant flow rates are maintained throughout the test.

(xiv) Three-way solenoid valves (V1, V2, V3, and V4) to direct sample streams to either their respective bags or overboard.

(xv) Quick-connect, leak-tight fittings (C1, C2, C3, and C4) with automatic shutoff on bag side to attach sample bags to sample system.

(xvi) Sample collection bags for dilution air and exhaust samples of sufficient capacity so as not to impede sample flow.

(xvii) Revolution counters to count the revolutions of the positive displacement pump while each test phase is in progress and samples are being collected.

(3) Component description (exhaust gas analytical system). The following components will be used in the exhaust gas analytical system for testing under the regulations in this part. The analytical system provides for the determination of hydrocarbon concentrations by flame ionization detector (FID) analysis, the determination of carbon monoxide and carbon dioxide concentrations by nondispersive infrared (NDIR) analysis and the determination of oxides of nitrogen concentrations by chemiluminescence (CL) analysis in dilute exhaust samples. The chemiluminescence method of analysis requires that the nitrogen dioxide present in the sample be converted to nitric oxide before analysis.

Other types of analyzers may be used if shown to yield equivalent results and if approved in advance by the Administrator. (See figure 2.)

(i) Quick-connect leak-tight fitting (C5) to attach sample bags to analytical system.

(ii) Filter (F3) to remove any residual particulate matter from the collected sample.

(iii) Pump (P3) to transfer samples from the sample bags to the analyzers.

(iv) Selector valves (V5, V6, V7, V8, V9, V10, V11, and V12) for directing samples, span gases or zeroing gases to the analyzers.

(v) Flow control valves (N3, N4, N5, N6, N7, N8, N9, N10, N11, N12, N13, N14, and N15) to regulate the gas flow rates.

(vi) Flowmeters (FL3, FL4, FL5, FL6, and FL7) to indicate gas flow rates.

(vii) Pressure gauges (G3 and G4) to facilitate greater precision in setting and reading flowmeters.

(viii) Manifold (MI) to collect the expelled gases from the analyzers.

(ix) Pump (P4) to transfer expelled gases from the collection manifold to a vent external to the test room (optional).

(x) Analyzers to determine hydrocarbon, carbon monoxide, carbon dioxide and oxides of nitrogen concentrations. (See Section X(a).)

(xi) Sample conditioning column containing $CaSO_4$ or indicating silica gel to remove water vapor and containing ascraite to remove carbon dioxide from the CO analysis stream.

NOTE.—If CO instruments which are essentially free of CO_2 and water vapor interference are used, the use of the conditioning column may be deleted. A CO instrument will be considered to be essentially free of CO_2 and water vapor interference if its response to a mixture of 3 percent CO_2 and N_2, which has been bubbled through water at room temperature (68–86° F), produces an equivalent CO response, as measured on the most sensitive CO range, which is less than 1 percent of full scale CO concentration on instrument ranges above 300 ppm CO or less than 3 ppm on instrument ranges below 300 ppm CO.

(xii) Recorders (R1, R2, R3, and R4) or digital printers to provide permanent records of calibration, spanning and sample measurements; or in those facilities where computerized data acquisition systems are incorporated, the computer facility printout may be used.

(b) Diesel vehicles. (1) Schematic drawings. The following figures (Figs. 3, 4, and 5) are schematic drawings of the exhaust gas sampling and analytical systems which will be used for testing under the regulations in this part. Since various configurations of the required components can produce accurate results, these schematic drawings are not to be interpreted literally and exact conformance is not mandatory. Additional components such as instruments, valves, solenoids, pumps, and switches may be used to provide additional information and coordinate the functions of the component systems.

(2) Components description (exhaust gas sampling system). The following components will be used in the exhaust gas sampling system for testing under the regulations in this part (see Fig. 3). Other types of constant volume samplers may be used if shown to yield equivalent results, and if approved in advanced by the Administrator.

(i) A dilution air filter assembly consisting of a particulate filter to remove solid matter from the dilution air and thus increase the life of the charcoal filter; a charcoal filter to reduce and stabilize the background hydrocarbon level; and a second particulate filter to remove charcoal particles from the air stream.

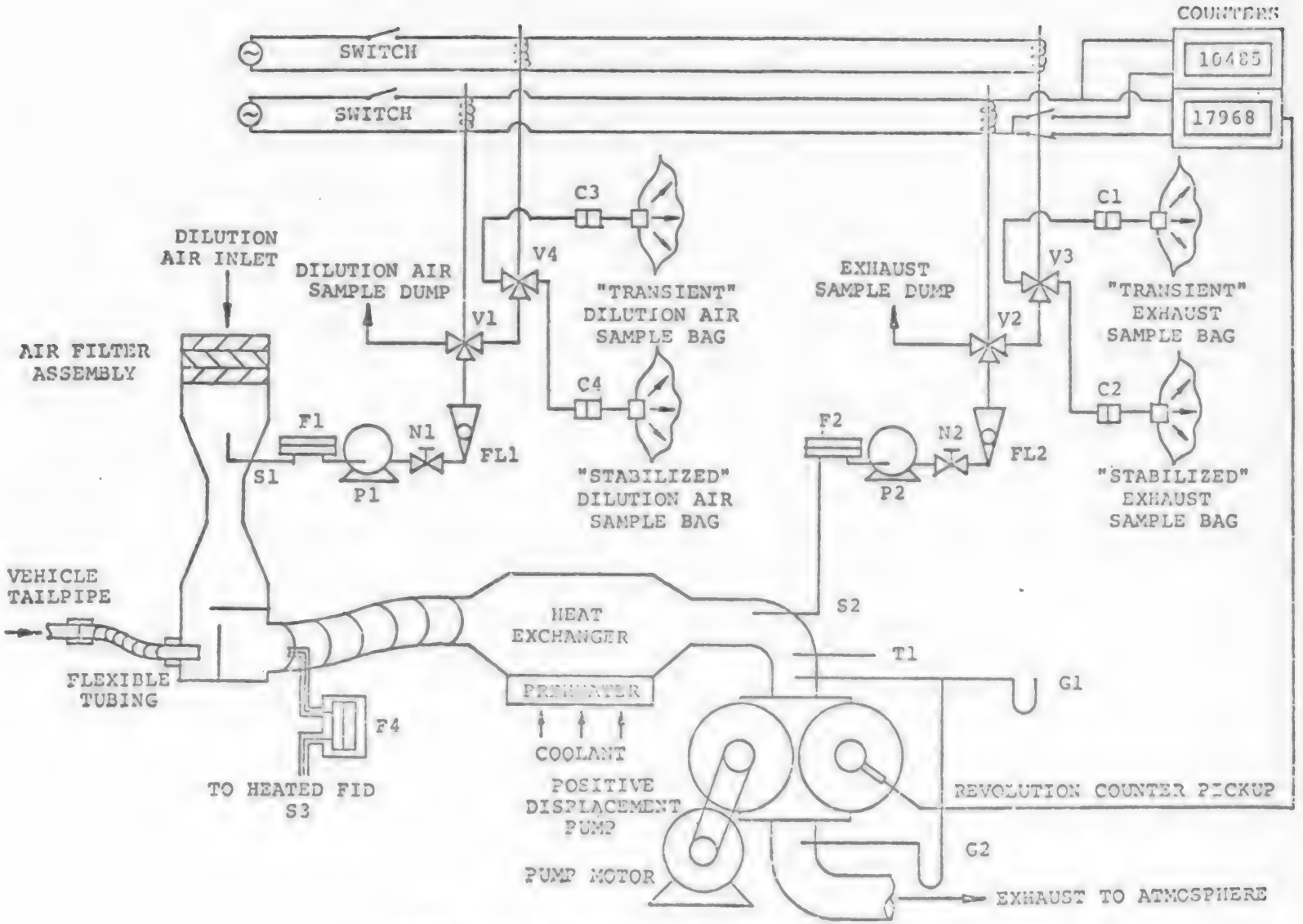

Figure 3 Exhaust Gas Sampling System

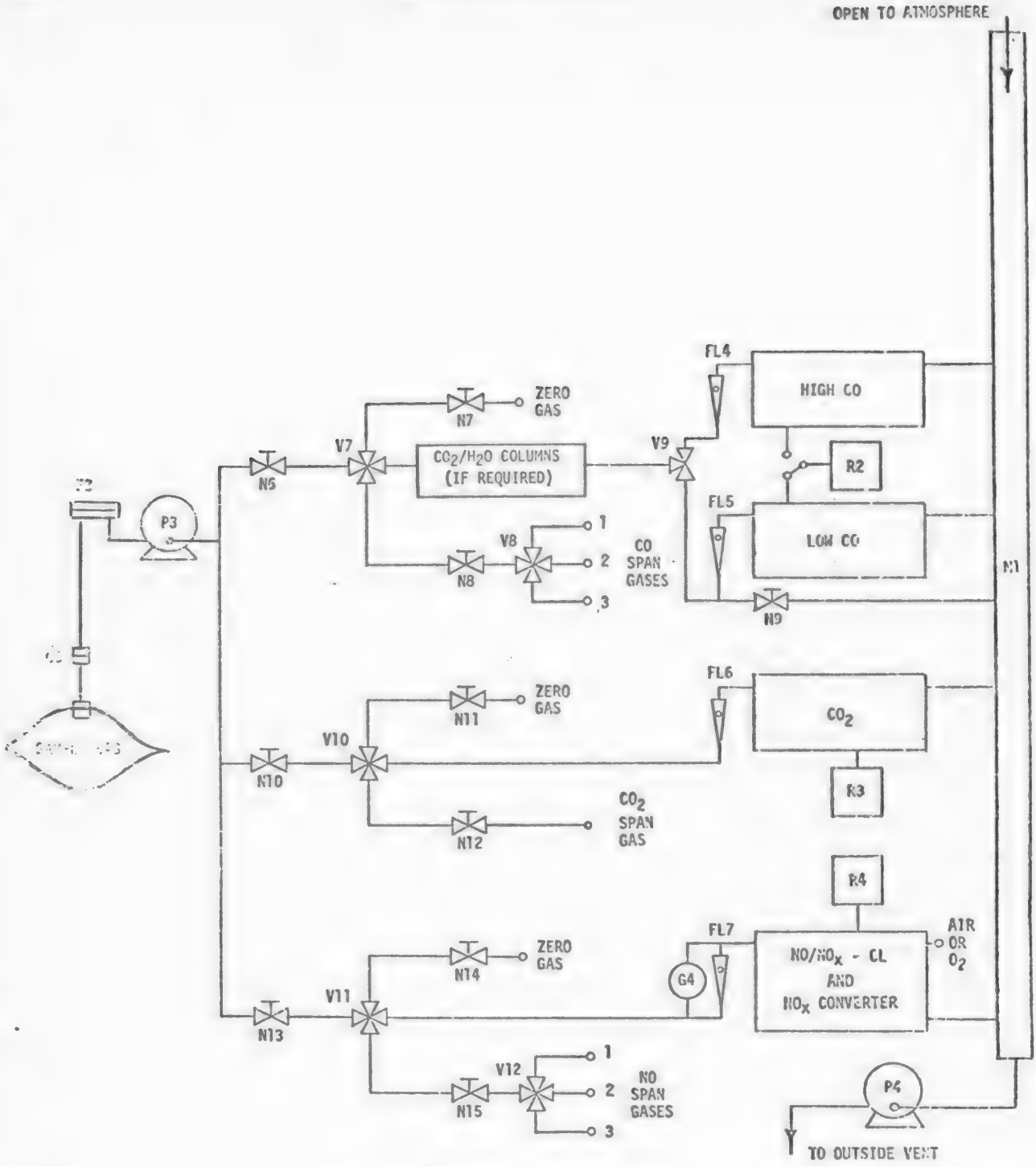

Figure 4 Exhaust Gas Analytical System

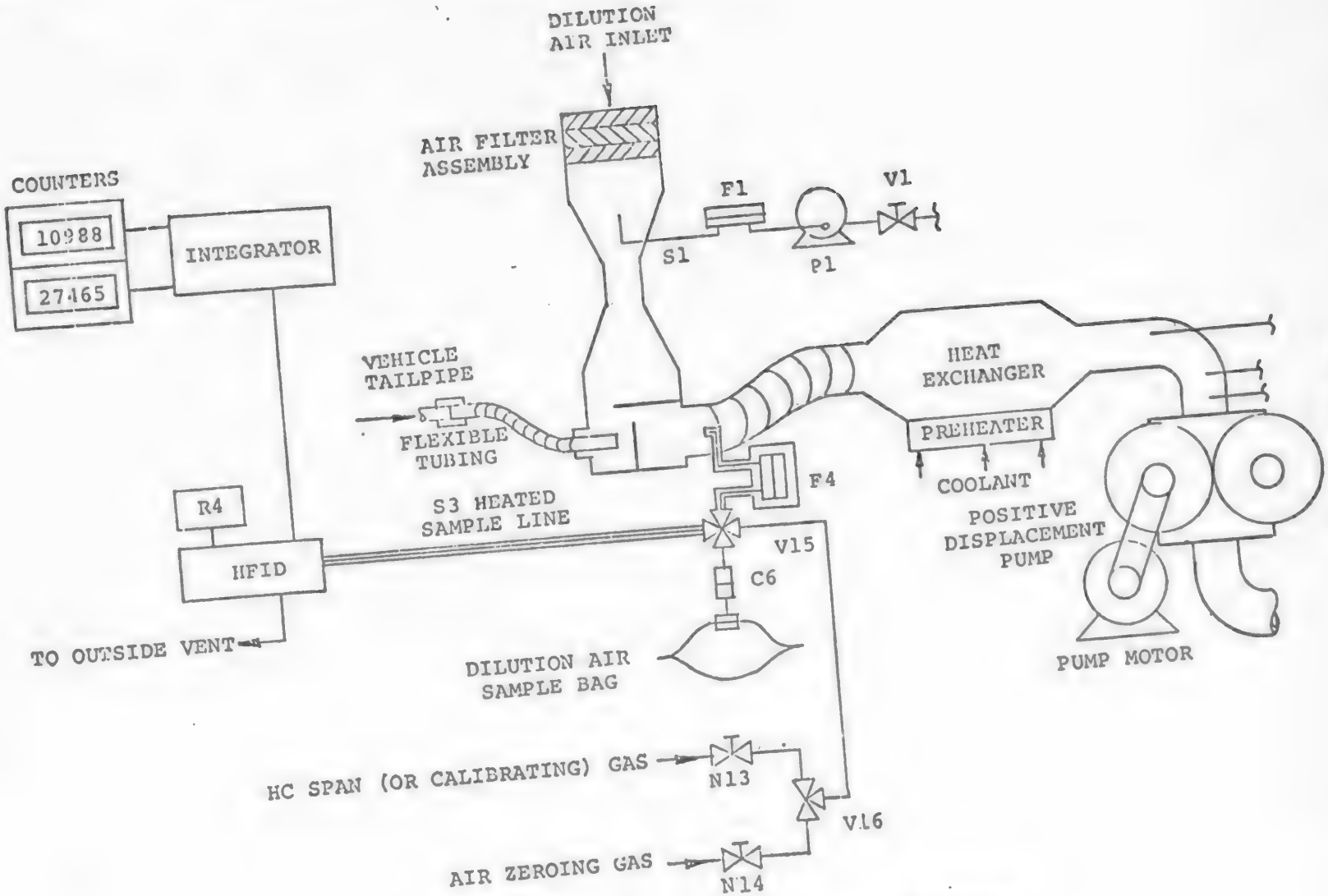

Figure 5 Diesel Hydrocarbon Continuous Analysis System

(ii) A leak-tight connector and tube to the vehicle tailpipe. The tubing shall be sized and connected in such a manner that the static pressure variations in the vehicle tailpipe(s) remain within ±5 inches of water of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe(s). Sampling systems capable of tolerance of ±1 inch of water will be used by the Administrator if a written request by the manufacturer substantiates the need for this closer tolerance.

(iii) A heating system to preheat the heat exchanger to within ±10° F of its operating temperature before the test begins.

(iv) A heat exchanger capable of limiting the gas mixture temperature variation during the entire test to ±10° F from the total test average as measured from a point immediately in front of the positive displacement pump.

(v) A positive displacement pump in order to pump dilute exhaust mixture. The pump capacity (300 to 350 c.f.m. is sufficient for testing most vehicles) shall be large enough to virtually eliminate water condensation in the system. See Appendix III to 40 CFR 86 for one-flow calibration technique. Other suitable calibration techniques may be used if approved in advance by the Administrator.

(vi) Temperature sensor (TI) with an accuracy of ±2° F to allow continuous recording of the temperature of the dilute exhaust mixture entering the positive displacement pump.

(vii) Gauge (G1) with an accuracy of ±3 mm. Hg to measure the pressure depression of the dilute exhaust mixture entering the positive displacement pump, relative to atmospheric pressure.

(viii) Gauge (G2) with an accuracy of ±3 mm. Hg to measure the pressure increase across the positive displacement pump.

(ix) Sample probes (S1, S2, and S3) pointed upstream to collect samples from the dilution airstream and the dilute exhaust mixture. Additional sample probes may be used, for example, to obtain continuous concentration traces of the dilute exhaust stream. In such cases the sample flow rate, in standard cubic feet per test phase, must be added to the calculated dilute exhaust volume. The position of the sample probes in Figure 3 is pictorial only. The heated sample line (S3) between the sampling point and the analyzer shall be as short as possible.

(x) Filters (F1 and F2) to remove particulate matter from dilution air and dilute exhaust samples.

(xi) Pumps (P1 and P2) to pump the dilution air and dilute exhaust into their respective sample collection bags.

(xii) Flow control valves (N1 and N2) to regulate flows to sample collection bags, at constant flow rates. The minimum sample flow rate shall be 10 c.f.h.

(xiii) Flowmeters (FL1 and FL2) to insure, by visual observation, that constant flow rates are maintained throughout the test.

(xiv) Three-way solenoid valves (V1, V2, V3, and V4) to direct sample streams to either their respective bags or overboard.

(xv) Quick-connect, leak-tight fittings (C1, C2, C3, and C4) with automatic shutoff on bag side to attach sample bags to sample system.

(xvi) Sample collection bags for dilution air and exhaust samples of sufficient capacity so as not to impede sample flow.

(xvii) Revolution counters to count the revolutions of the positive displacement pump while each test phase is in progress and samples are being collected.

(3) Component description (exhaust gas batch analytical system). The following components will be used in the exhaust gas batch analytical system for testing under the regulations in this part. The analytical system provides for the determination of carbon monoxide and carbon dioxide concentrations by nondispersive infrared (NDIR) analysis and the determination of oxides of nitrogen concentrations by chemiluminescence (CL) analysis in dilute exhaust samples. The chemiluminescence method of analysis requires that the nitrogen dioxide present in the sample be converted to nitric oxide before analysis. Other types of analyzers may be used if shown to yield equivalent results and if approved in advance by the Administrator. (See Figure 4.)

(i) Quick-connect, leak-tight fitting (C5) to attach sample bags to analytical system.

(ii) Filter (F3) to remove any residual particulate matter from the collected sample.

(iii) Pump (P3) to transfer samples from the sample bags to the analyzers.

(iv) Selector valves (V7, V8, V9, V10, V11, and V12) for directing samples, span gases or zeroing gases to the analyzers.

(v) Flow control valves (N6, N7, N8, N9, N10, N11, N12, N13, N14, and N15) to regulate the gas flow rates.

(vi) Flowmeters (FL4, FL5, FL6, and FL7) to indicate gas flow rates.

(vii) Pressure gauge (G4) to facilitate greater precision in setting and reading flow rate.

(viii) Manifold (M1) to collect the expelled gases from the analyzers.

(ix) Pump (P4) to transfer expelled gases from the collection manifold to a vent external to the testroom (optional).

(x) Analyzers to determine carbon monoxide, carbon dioxide and oxides of nitrogen concentrations.

(xi) Sample conditioning column containing $CaSO_4$, or indicating silica gel to remove water vapor and containing ascraite to remove carbon dioxide from the CO analyses stream.

NOTE.—If CO instruments which are essentially free of CO_2 and water vapor interference are used, the use of the conditioning column may be deleted. A CO instrument will be considered to be essentially free of CO_2 and water vapor interference if its response to a mixture of 3 percent CO_2 in N_2, which has been bubbled through water at room temperature (68°–86° F) produces an equivalent CO response, as measured on the most sensitive CO range, which is less than 1 percent of full scale CO concentration on instrument ranges above 300 ppm CO or less than 3 ppm on instrument ranges below 300 ppm CO.

(xii) Recorders (R2, R3, and R4) or digital printers to provide permanent records of calibration, spanning and sample measurements; or in those facilities where computerized data acquisition systems are incorporated, the computer facility printout may be used.

(4) Component description (exhaust gas continuous analytical system). The following components will be used in the exhaust gas continuous analytical system for testing under the regulations in this part. This analytical system provides for the continuous determination of exhaust hydrocarbon concentration by heated flame ionization detector (HFID) analysis. Other types of analyzers may be used if shown to yield equivalent results and if approved in advance by the Administrator. (See Figure 5.)

(i) Heated continuous sampling line (S3).

(ii) Heated filter (F4) to remove particulate matter from heated hydrocarbon sample.

(iii) Selector valves (V15 and V16) for directing the continuous dilute exhaust sample, dilution air bag sample, span or zeroing gases to the analyzers.

(iv) Quick-connect, leak-tight fitting (C6) to attach dilution air sample bag to analytical system.

(v) Heated hydrocarbon analyzer (HFID) complete with heated pump, filter, and flow control system. The response time of this instrument shall be less than 1 second for 90 percent of full scale response. Sample transport time from sampling point to inlet of instrument shall be less than 4 seconds. The sample line and filter shall be heated to a set point ±10° F (±5.6° C) between 300° and 390° F (149° and 199° C).

(vi) Chart recorder (R4) and analog integrator with two readouts, or chart recorder (R4) and on-line digital computer for manual or electronic integration of analyzer output signal during the three operating phases of the test.

(vii) Flow control valves (N13 and N14) to regulate the gas flow rates.

X. SYSTEM CALIBRATION

For the procedures and specifications to calibrate the dynamometer, CVS and analytical systems see sections 40 CFR 86.118-78 through 86.126-78 and 86.114-78 in the June 28, 1977, FEDERAL REGISTER.

XI. DYNAMOMETER TEST RUNS

(a) The vehicle shall be allowed to stand with the engine turned off for a period of not less than 11 hours before the start of the heat build. The vehicle shall be stored prior to the emission tests in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The complete dynamometer test consists of a cold start drive of 7.5 miles and a hot start drive of 7.5 miles. The vehicle is allowed to stand on the dynamometer during the 10-minute time period between the cold and hot start test. The cold start test is divided into two periods. The first period, representing the cold start "transient" phase, terminates at the end of the deceleration which is scheduled to occur at 505 seconds into the driving schedule. The second period, representing the "stabilized" phase, consists of the remainder of driving schedule including engine shutdown. The hot start test similarly consists of two periods. The first period, representing the hot start "transient" phase, terminates at the same point in the driving schedule as the first phase of the cold start test. The second period of the hot start test, "stabilized" phase, is assumed to be identical to the second period of the cold start test. Therefore, the hot start test terminates after the first period (505 seconds) is run. During the tests the ambient temperature shall be between 68° and 86° F.

(b) The following steps shall be taken for each test. Several steps are described in terms of using a positive displacement pump. Similar operations appropriate to CFV should be followed by manufacturers utilizing this equipment.

(1) Place drive wheels of vehicles on dynamometer without starting engine.

(2) Open the vehicle engine compartment cover and start the cooling fan.

(3) With the sample solenoid valves in the "dump" position connect evacuated sample

collection bags to the dilute exhaust sample connectors and to the dilution air sample line connectors.

(4) Start the positive displacement pump (if not already on), the sample pumps, heated hydrocarbon analysis recorder (Diesel only) and the temperature recorder. (The heat exchanger of the constant volume sampler, the Diesel hydrocarbon analyzer continuous sample line and filter, if applicable, should be preheated to their respective operating temperatures before the test begins.)

(5) Adjust the sample flow rates to the desired flow rate (minimum of 10 c.f.h.) and set the revolution counters to zero. Also set Diesel hydrocarbon integrator counters to zero, if applicable.

(6) Attach the flexible exhaust tube to the vehicle tailpipe(s).

(7) Simultaneously start the revolution counter for the positive displacement pump, position the sample solenoid valves to direct the sample flow into the "transient" exhaust sample bag and the "transient" dilution air sample bag, (turn on the Diesel hydrocarbon analyzer system integrator and mark the recorder chart, if applicable) and start cranking the engine.

(8) Fifteen seconds after the engine starts, place the transmission in gear.

(9) Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule.

(10) Operate the vehicle according to the dynamometer driving schedule (see section V).

(11) At the end of the deceleration which is scheduled to occur at 505 seconds, simultaneously switch the sample flows from the "transient" bags to the "stabilized" bags, switch off revolution counter No. 1 (and the Diesel hydrocarbon integrator No. 1, mark the Diesel hydrocarbon recorder chart) and start counter No. 2 (and the Diesel hydrocarbon integrator No. 2). Before the acceleration which is scheduled to occur at 510 seconds, record the measured roll or shaft revolutions and reset the counter or switch to a second counter. Disconnect the "transient" exhaust and dilution air sample bags and transfer them to the analytical systems. As soon as possible and in no case longer than 20 minutes after the end of sampling, process the exhaust sample according to section XII.

(12) Turn engine off 2 seconds after the end of the last deceleration (at 1,369 seconds).

(13) Five seconds after the engine stops running, simultaneously turn off revolution counter No. 2 (and the Diesel hydrocarbon integrator No. 2, mark the hydrocarbon recorder chart, if applicable) and position the sample solenoid valves to the "dump" position. Disconnect the "stabilized" exhaust and dilution air sample bags and transfer them to the analytical system. As soon as possible and in no case longer than 20 minutes after the end of sampling, process the exhaust sample according to section XII.

(14) Immediately after the end of the sample period turn off the cooling fan and close the engine compartment cover.

(15) Turn off the positive displacement pump or disconnect the exhaust tube from the tailpipe(s) of the vehicle.

(16) Repeat the steps in paragraphs (b)(2) through (10) of this section for the hot start test except only one evacuated sample bag is required for sampling exhaust gas and one for dilution air. The step in paragraph (b)(7) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

(17) At the end of the deceleration which is scheduled to occur at 505 seconds, simultaneously turn off the No. 1 revolution counter (and Diesel hydrocarbon integrator No. 1, mark the Diesel hdrocarbon recorder chart, if applicable) and position the sample solenoid valve to the "dump" position.

NOTE.—Engine shutdown is not part of the hot start test sample period. Record the measured roll or shaft revolutions.

(18) Disconnect the hot start "transient" exhaust and dilution air sample bags and transfer them to the analytical system. As soon as possible and in no case longer than 20 minutes after the end of this portion of the test process the exhaust sample according to section XII.

(19) Disconnect the exhaust tube from the vehicle tailpipe(s) and the vehcle may be removed from the dynamometer.

(20) The positive displacement pump may be turned off, if desired.

XII. HC, CO, CO_2, AND NO_x MEASUREMENTS

When testing Diesel vehicles allow the HC analyzer sample line and filter to heat to a set point ±10° F between 300° and 390° F. Allow a minimum of 20 minutes warmup for the HC analyzer and 2 hours for the CO, CO_2, and NO_x analyzer. (Power is normally left on infrared and chemiluminescence analyzers; but when not in use, the chopper motors of the infrared analyzers are turned off and the phototube high voltage supply of the chemiluminescence analyzers is placed in the standby position.) The following sequence of operations should be performed in conjunction with each series of measurements:

(a) Zero the analyzers. Obtain a stable zero on each amplifier meter and recorder. Recheck after tests.

(b) Introduce span gases and set the CO and CO_2 analyzer gains, the HC analyzer sample capillary flow rate and the NO_x analyzer high voltage supply or amplifier gain to match the calibration curves. In order to avoid corrections, span and calibrate at the same flow rates used to analyze the test samples. Span gases should have concentrations equal to 75 to 100 percent of full scale. If gain has shifted significantly on the CO or CO_2 analyzers, check tuning. If necessary, check calibration. Recheck after tests. Show actual concentrations on chart.

(c) Check zeros; repeat the procedure in paragraphs (a) and (b) of this section if required.

(d) Check flow rates and pressures.

(e) For Diesel vehicles continuously record (and integrate electronically, if desired) dilute hydrocarbon emission levels during test.

(f) Measure CO, CO_2, and NO_x concentrations of samples, also HC for gasoline-fueled vehicles. Care should be exercised to prevent moisture from condensing in the sample collection bag.

(g) Check zero and span points. If the difference is greater than 2 percent of full scale, repeat the procedure in paragraphs (a) through (g) of this section.

(h) Repeat the procedures for the sample bag analysis, paragraphs (a) through (g) of this section, to analyze the ambient bag.

XIII. CHART READING

(a) Gasoline-fueled light duty vehicles and light duty trucks:

(1) Determine the HC, CO, CO_2, and NO_x concentrations of the dilution air and dilute exhaust sample bags from the instrument deflections or recordings making use of appropriate calibration charts.

(2) Determine the pressure of the mixture of exhaust and dilution air entering the CVS metering device, the pressure increase across the device, and the temperature at the inlet. The temperature may be recorded continuously or digitally to determine temperature variations.

(3) Determine the number of revolutions of the positive displacement pump accumulated during each test phase while exhaust samples are being collected. The number of standard cubic feet metered by a critical flow venturi during each test phase would be the equivalent record for a CFV-CVS.

(4) Determine the driving distance for each of the three phases of the test, calculated from the measured roll of shaft revolutions.

(b) Diesel light duty vehicles and light duty trucks:

(1) Determine the HC, CO, CO_2, and NO_x concentrations of the dilution air and the CO, CO_2, and NO_x concentrations of the dilute exhaust sample bags from the instrument deflections, computer printouts, or recordings making use of appropriate calibration charts.

(2) Record integrated HC results, or manually integrate continuous chart. This chart provides a permanent record and can be graphically integrated if verification of the results of electronic integration is required.

(3) Determine the pressure of the mixture of exhaust and dilution air entering the CVS metering device, the pressure increase across the device, and the temperature at the inlet. The temperature may be recorded continuously or digitally to determine temperature variations.

(4) Determine the number of revolutions of the positive displacement pump accumulated during each test phase while exhaust samples are being collected. The number of standard cubic feet metered by a critical flow venturi during each phase would be the equivalent record for a CFV-CVS.

(5) Determine the driving distance for each of the three phases of the test, calculated from the measured roll of shaft revolutions.

XIV. CALCULATIONS

The individual reported test results shall be computed by use of the following formula:

(a) For light duty vehicles and light duty trucks:

$$Ywm = 0.43((Yct + Ys)/(Dct + Ds)) + 0.57((Yht + Ys)/(Dh + Ds)).$$

Where:

Ywm = Weighted mass emissions of each pollutant, i.e., HC, CO, NO_x, or CO_2 in grams per vehicle mile.

Yct = Mass emissions as calculated from the "transient" phase of the cold start test in grams per test phase.

Yht = Mass emissions as calculated from the "transient" phase of the hot start test in grams per test phase.

Ys = Mass emissions as calculated from the "stabilized" phase of the cold start test, in grams per test phase.

Dct = The measured driving distance from the "transient" phase of the cold start test in miles.

Dht=The measured driving distance from the "transient" phase of the hot start test in miles.
Ds=The measured driving distance from the "stabilized" phase of the cold start test, in miles.

(b) The mass of each pollutant for each phase of both the cold start test and hot start test is determined from the following:

(1) Hydrocarbon mass:

HCmass=Vmix×DensityHC×HCconc/1,000,000

(2) Oxides of nitrogen mass:

NO_xmass=Vmix×DensityNO_x×(NO_x conc/1,000,000)×KH

(3) Carbon monoxide mass:

COmass=Vmix×DensityCO×COconc/1,000,000

(4) Carbon dioxide mass:

CO_2mass=Vmix×DensityCO_2×CO_2 conc/100

(c) Meaning of symbols:

(1) HCmass=Hydrocarbon emissions, in grams per test phase.

DensityHC=Density of hydrocarbons in the exhaust gas, assuming an average carbon to hydrogen ratio of 1:1.85, in grams per cubic foot at 68° F and 760 mm. Hg pressure (16.33 gm./cu.ft.).
HCconc=Hydrocarbon concentration of the dilute exhaust sample corrected for background, in p.p.m. carbon equivalent, i.e. equivalent propane×3. HCconc=HCe−HCd(1−1/DF).

Where:

HCe=Average hydrocarbon concentration of the dilute exhaust sample as measured from the sample bag or for Diesel, average hydrocarbon concentration of the dilute exhaust sample, as calculated from the integrated HC traces, in p.p.m. carbon equivalent.
HCd=Hydrocarbon concentration in the dilution air as measured in p.p.m. carbon equivalent.

(2) NO_xmass=Oxides of nitrogen emissions, in grams per test phase.

DensityNO_x=Density of oxides of nitrogen in the exhaust gas, assuming they are in the form of nitrogen dioxide, in grams per cubic foot at 68° F and 760 mm. Hg pressure (54.16 gm./cu. ft.)
NO_xconc=Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in p.p.m. NO_xconc=NO_xe−NO_xd (1−1/DF).

Where:

NO_xe=Oxides of nitrogen concentration of the dilute exhaust sample as measured, in p.p.m.

(3) COmass=Carbon monoxide emissions, in grams per test phase.

DensityCO=Density of carbon monoxide in grams per cubic foot at 68° F and 760 mm. Hg pressure (32.97 gm./cu ft.).
COconc=Carbon monoxide concentration of the dilute exhaust sample corrected for background, water vapor and CO_2 extraction, in p.p.m. COconc=COe−COd (1−1/DF).

Where:

COe=Carbon monoxide concentration of the dilute exhaust sample volume corrected for water vapor and carbon dioxide extraction, in p.p.m. The calculation assumes the carbon to hydrogen ratio of the fuel is 1:1.85. COe=(1−0.01925 CO_2e−0.000323R) COem.

Where:

COem=Carbon monoxide concentration of the dilute exhaust sample as measured in p.p.m.
CO_2e=Carbon dioxide concentration of the dilute exhaust sample, in mole percent.
R=Relative humidity of the dilution air, in percent.
COd=Carbon monoxide concentration of the dilution air corrected for water vapor extraction, in p.p.m.
COd=(1−0.000323R) COdm.

Where:

COdm=Carbon monoxide concentration of the dilution air sample as measured, in p.p.m.

NOTE.—If a CO instrument which meets the criteria specified in section XI(a)(3)(xi) or section XI(b)(3)(xi) is used and the conditioning column has been deleted, COem can be substituted directly for COe and COdm can be substituted directly for COd.

(4) CO_2mass=Carbon dioxide emissions, in grams per test phase.

DensityCO_2=Density of carbon dioxide is 51.85 g/ft³ (1.843 kg/M³), at 68° F (20° C) and 760 mm Hg (101.3 kPa) pressure.
CO_2conc=Carbon dioxide concentration of the dilute exhaust sample corrected for background, in percent.
CO_2conc=CO_2e−CO_2d(1−1/DF)

Where:

CO_2d=Carbon dioxide concentration of the dilution air as measured, in percent.

(5) DF=13.4/[CO_2e+(HCe+COe)10−4]

KH=Humidity correction factor
KH=1/[1−0.0047(H−75)]
for SI units=1/1−0.0329(H−10.71)]

Where:

H=Absolute humidity in grains (grams) of water per pound (kilogram) of dry air.
H=[(43.478)Ra×Pd]/[PB−(Pd×Ra/100)]
for SI units, H=[(6.211)Ra×Pd]/PB−(Pd×Ra/100)]
Ra=Relative humidity of the ambient air, in percent.
Pd=Saturated vapor pressure, in mm. Hg (kPa) at the ambient dry bulb temperature.
PB=Barometric pressure, in mm. Hg (kPa).
Vmix=Total dilute exhaust volume in cubic feet per test phase corrected to standard conditions (528 R) (293 K) and 760 mm. Hg (101.3 kPa).

For PDP-CVS, Vmix is:

Vmix=Vo×N(PB−P4) 528 R/(760 mm. Hg) (Tp)

for SI units,

Vmix=Vo×N(PB−P4) (293.15 K)/(101.325 kPa) (Tp)

Where:

Vo=Volume of gas pumped by the positive displacement pump, in cubic feet (m3) per revolution. This volume is dependent on the pressure differential across the positive displacement pump.
N=Number of revolutions of the positive displacement pump during the test phase while samples are being collected.
PB=Barometric pressure, in mm. Hg (kPa).
P4=Pressure depression below atmospheric measured at the inlet to the positive displacement pump, in mm. Hg (kPa) (during an idle mode).
Tp=Average temperature of dilute exhaust entering positive displacement pump during test, R(K).

(d) Example calculation of mass emissions values:

(1) For the "transient" phase of the cold start test assume Vo=0.29344 cu. ft. per revolution; N=10,485; R=48.0 percent; Ra=48.2 percent; PB=762 mm. Hg; Pd=22.225 mm. Hg;

P4=70 mm. Hg; Tp=570 R; HCe=105.8 p.p.m. carbon equivalent: NOxe=11.2 p.p.m.; COem=306.6 p.p.m.; CO2e=1.43 percent; HCd=12.1 p.p.m.; NOxd=0.8 p.p.m.; COdm=15.3 p.p.m.

Then:

Vmix=(0.029344) (10,485) (762-70) (528)/(760) (570)=2595 cu. ft. per test phase.
H=(43.378) (48.2) (22.225)/762−(22.225×48.2/100)=62 grains of water per pound of dry air.
Kh=1/1−0.0047(62−75)=.9424.
COe=(1−0.01925(1.43) −0.000323(48))306.0=293.4 p.p.m.
COd=(1−0.000323(48))15.3=15.1 p.p.m.
DF=13.4/1.43+(105.8+293.4)×10−4=9.116.
HCconc=105.8−12.1(1−1/9.116)=95.03 p.p.m.
HCmass=(2595) (16.33) (95.03/1,000,000) =4.027 grams per test phase.
NO_xconc=11.2−0.8(1−1/9.116)=10.49 p.p.m.
NO_xmass=(2595) (54.16) (10.49/1,000,000) (0.9424)=1.389 grams per test phase.
COconc=293.4−15.1(1−1/9.116)=280.0 p.p.m.
COmass=(2595) (32.97) (280/1,000,000) =23.96 grams per test phase.
CO_2conc=1.43−.032(1−1/9.116)=1.402 percent.
CO_2mass=(2595.0) (51.85) (1.402/100)
CO_2mass=1886 grams per test phase.

(2) For the "stabilized" portion of the cold start test assume that similar calculations resulted in HCmass=0.62 gram per test phase; NO_xmass=1.27 grams per test phase; and COmass=5.98 grams per test phase.

(3) For the "transient" portion of the hot start test assume that similar calculations resulted in HCmass=0.51 gram per test phase; NO_xmass=1.38 grams per test phase; and COmass=5.01 grams per test phase; CO_2mass=1758 grams per test phase; Dht=3.598 miles.

(4) Weighted mass emission results:

HCwm=0.43 [(4.027+0.62)/(3.598+3.902)]+0.57 [(0.51+0.62)/(3,598+3,902)]=0.352 gram per vehicle mile.

NO_xwm = 0.43 [(1.389 + 1.27)/(3.598 + 3.902)] + 0.57 [(1.38 + 1.27)/(3.598 + 3.902)] = .354 gram per vehicle mile.

COwm = 0.43 [(23.96 + 5.98)/(3.598 + 3.902)] + 0.57 [(5.01 + 5.98)/(3.598 + 3.902)] = 2.55 grams per vehicle mile.

CO_2wm = 0.43 [(1886 + 2346)/(3.598 + 3.902)] + 0.57 [(1758 + 2346)/(3.598 + 3.902)] = 555 grams per vehicle mile.

(Secs. 206, 208, 301(a), Clean Air Act, as amended (42 U.S.C. 7525, 7542, 7601(a), formerly (42 U.S.C. 1857f-5, 1857f-6, 1857g(a)) which was reclassified by 91 Stat. 685 (Aug. 7, 1977)).)

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